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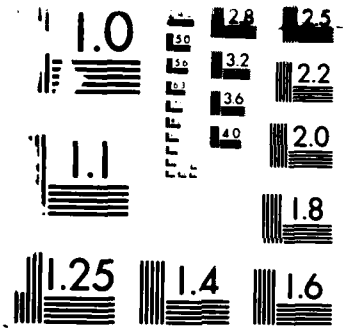

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The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

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Fractrue failure of composite meterials; Boron Fiber metal Matrix composite Material; Fatigue Failure; Nature of Failure.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The boron, aluminum composite material samples were cut to shape and subjected to push-pull type of loading under Instron Servo Hydrolic test system to failure. The failure surfaces were examined under electron microscope. The data collected under about ten experiments were used for an M.S.E. thesis of one graduate student. [illegible] work by the end of this period.

STUDY OF THE NATURE OF FRACTURE FAILURE

IN

COMPOSITE MATERIALS

FINAL REPORT

BY

R.N.S. RAO

DECEMBER 1, 1986

U.S. ARMY RESEARCH OFFICE

GRANT NO. DAAG29-85-G-0123

COLLEGE OF ENGINEERING

PRAIRIE VIEW A&M UNIVERSITY

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REPORT

ON

STUDY OF THE NATURE OF FRACTURE IN COMPOSITE MATERIALS

Statement of the Problem: In recent years the Boron/Aluminium Composite Materials is being extensively used in the space transportation vehicles and aviation industry. From the studies conducted, eventhough this material seems to satisfy the required strength and weight characteristic needed by the industry, there is still lack of data to support these qualities of the material unequivocally to justify large scale manufacturing of the same with standard specifications. This study was taken up to supplement this meeded data to fill that gap.

At present the data is limited and some of them are propritory. The lack of broad based manufacturing of the material within the nation makes it difficult for adoption as a material for defense needs of the nation.

The study involves the performances of a series of tests on boron fiber aluminium matrix material of given fiber orientation and volume content. The type of test proposed is the fatigue test of push-pull type. This data on the nature of fracture along with the curent data available must be able to draw better conclusions of correlation between fatigue strength and the characteristics of the composite material.

Summary of Progress Made: To conduct the tests; it was contemplated to have a new instron servo hydraulic system, model 1332 of 55 kips capacity with programmed digital monitoring attachment. The actual procurement of this equipment took most of the year 1983-84. Once the equipment was installed, it was found that it was not functioning properly. The process of finding the root cause of the problems and bringing it to operational order along with training a personnel to operate, took more time than anticipated.

The first set of specimen needed for the experiments was determined and finding a supplier to get the same took much more time than originally contemplated. Finally DWA Composite Specialities supplied the first set of twenty specimens by March 1985.

As the first two years of this study was coming to a close attempts were made to have the first few testing of these specimens during this period.

The specimens used for this study are 0.885"x2"x12" with 45% fiber concentration. The simple tensile test was conducted on one of the specimen to familarize the mechanical behavior of boron-aluminum matrix composite materials under the tensile load and the other ten specimens were subjected to unidirectional push-pull fatigue test by strain control to investigate the fatigue failure. Some samples were examined before and after experiments in a scanning electron microscope to get a better insight into the nature of the fatigue damage. The results show that the fracture is mainly due to the crack of fibers but not due to

Since most low-cycle fatigue theory for isotropic materials was developed based on cyclic plastic strain, it is predictable that the low cycle fatigue life of boron-aluminum composites is governed by the cyclic plastic strain, fiber concentration and the orientation of the fibers. From the experimental data collected an attempt was made to derive the relation of low-cycle fatigue damage and the cyclic palstic strain as well as fiber concentration. Additional experimental data are needed to support this study.

During this period additional personnel in the College of Engineering were involved on this project to draw in experience from wider segments of the faculty members.

In the meanwhile, many visits were made to the Aerospace Engineering and Biological Science Laboratories of Texas A&M University, to acquaint with the electronic microscope they have. This facility is within 50 miles from Prairie View and forms a part of the Texas A&M University System, of which Prairie View A&M University is a part. Initial micrograph pictures gives an idea of the corss-section of the specimen and the density of fibers in them.

List of Technical Reports: The following half yearly progress reports and presentations at local faculty research meetings have been made:

1) Half yearly progress report dated December 31, 1983

2) Half yearly progress report dated June 30, 1984

3) College of Engineering Faculty Research Meeting Presentation on June 15, 1984.

4) Undergraduate Investigation report by Mr. Micah Massaquoi, December 1984.

5) Undergraduate Investigation report by Mr. Francis Amagoh, December 1984.

6) Half yearly progress report dated December 31, 1984.

7) Half yearly progress report dated June 30, 1985.

8) The final report on the first phase of the program data November 1, 1985.

9) Half yearly progress report dated June 30, 1986.

10) The Master of Science in Engineering Thesis by Mr. Francis Amagoh, August 1986.

List of Participating Technical Personnel:

1) R.N.S. Rao Ph.D., P.E., Professor of Civil Engineering

2) H. Y. Yeh Ph.D., P.E., Associate Professor of Civil Engineering

3) Miach Massaquoi, Graduate Student January 1, 1984 to May 31, 1984

4) Francis Amagoh, Graduate Student January 1, 1984 to August 31, 1986

5) C. T. Luke Assistant Professor of Civil Engineering

Mr. Miach Massaquoi and Mr. Francis Amagoh worked as undergraduate student assistants on the project from May 1, 1983 to December 31, 1983.

Degrees earned while being Employed on this Project: The following to students enrolled as undergraduate students had [illegible] their irvestigation paper. [illegible]

a requirement for the undergraduate degree of B.S. in Civil Engineering, while working on the project.

1) Miach Massaquoi, December 1983

2) Francis Amagoh, December 1983

The following student completed his thesis for his Master of Science in Engineering (M.S.E.) in August 1986

1) Francis Amagoh

Recommendations for the Future: The necessary preparation for conducting the experiments have been made so far. In order to see that all the work done so far do not go to waste, it is necessary to continue the project to ensure completion of experiments to draw more comprehensive conclusions.

Completion of the study will also ensure continuous coordinated efforts between the Army Research Office and Prairie View A&M University in the future.

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